

VANDERBILT UNIVERSITY



School of Medicine

Section of Surgical Sciences

Michael S. Golinko, MD, FAAP, FACS

Chief of Pediatric Plastic Surgery

Director of the Cleft and Craniofacial Program

October 7, 2021

Re: Suckley v. City of Williston – Expert Report

Dear Mr. Schmidt:

The following report details our research and my personal experience & expert opinion with regard to dog bite injuries in children. In full disclosure, I am a pediatric craniofacial plastic surgeon at Vanderbilt University Medical Center who frequently treats the primary injury and/or the secondary deformities that stem from dog bite injuries. I'm also a parent of two children under 5 years old and the owner of a Golden Retriever. A true and correct copy of my CV is attached to this report as well as a list of all publications that I have authored in the previous 10 years, a list of cases in which I have testified in the past 4 years, and a copy of my fee schedule for this case.

Personal Experience & Origin of Research Interest

The two articles attached detail our clinical outcome research efforts in this space. The research stemmed from my direct experience treating dog bite injuries as a plastic surgery fellow in Atlanta from 2011-2014. In addition to the normal 3-4 nights of call per month, our program had a Children's Healthcare of Atlanta (CHOA) Emergency Room (ER) moonlighting program. This afforded us the opportunity to work in the ER from 6-10 pm on any given night of the year and simply assess and sew up lacerations in children due to any cause.

Over the course of my three year training at Emory in Atlanta, I probably spent nearly 1,000 hours managing facial trauma. Thanks to the moonlighting experience, nearly 40% of my time was spent managing lacerations of any origin in children under 20 years of age. During that time, a pattern emerged in the stories we heard from caregivers who brought their children into the ER for a dog bite injury. There was an preponderance, especially in the more severe injuries, that "pit bull or pit mix" was mentioned. More often than not, the dog was known to the family and not a stray. I can also say from communication with my other 8 plastic surgery co-residents at the time, although anecdotal, that my experience was not unique. As someone who wanted to pursue pediatric plastic surgery as a career, being a child safety advocate naturally came as part of the territory. We set out to study the dog bite injuries at our institution .

D-4207 Medical Center North
Nashville, TN 37232-2345

tel 615.875-7222
fax 615.936.0167
Assistant – Shayla Sanders

Exhibit #2
1:21-cv-00012

Atlanta Experience: Characteristics of 1616 Consecutive Dog Bites at a Single Institution Clinical Pediatrics 2017 Vol 56(4) 316-325

This first retrospective study was one of the largest single institution, peer-reviewed reports on triage and management of dog bite injuries from the ER setting. All patients, 20 years old and under, were included who had a dog bite injury and were brought to the CHOA ER. 1,616 patients were included in the 4-year study. The mean age was 6.8 years old, with about half of patients being 5-12 years of age, and 26% being 1-5 years old. The methodology was retrospective chart review, and as such, not all outcome variables could be measured and one sure limitation of the study was that breed was mentioned in only 31.3% (509) patients. Thus, the breed-specific analysis only used this subset of 509 patients. Breed, and importantly if the dog was the family dog known to the family or a stray, was recorded and collated from the ED provider who saw the child. This was often corroborated in the plastic surgeon's note (such as myself). Other breeds were identified as shown below in Figure 1:

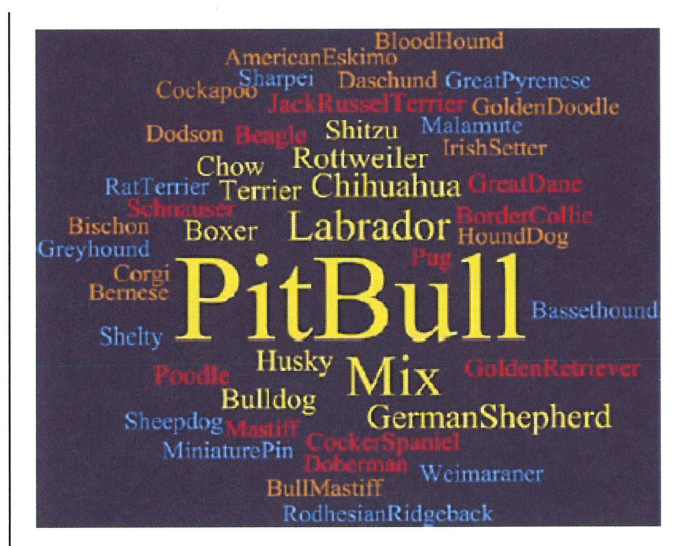


Figure 1. Word cloud of the frequency of breeds identified.

The 3 most prevalent reported breeds were:

- 38.5% pit bull (also identified as Staffordshire bull terrier, American Staffordshire terrier, or bull terrier)
- 13.0% mixed breeds
- 8.1% labradors

In our study we also reviewed 8 other large series breeds where we examined dog bites in children (see attached). In all but two studies, pit bulls were the largest percentage of biting dog.

We admit a limitation is a confirmation bias that there was no independent verification of the pit bull breed (i.e., with genetic testing). However, in effect, since there was no bias in NOT independently verifying any breed, one can assume pit bulls might have been incorrectly identified as much as any other breed. Even accounting for this uncertainty, the data is compelling.

Examining just the most severe injuries (i.e., the 89 patients that underwent surgery), nearly 70% involved the head and neck region and 50% involved pit bull breeds. There was over a 3-times greater risk in the injury being treated in the operating room (OR) (as a proxy for severity of injury) when a pit bull was identified as the biting dog.

We also examined anatomical location by looking at the ER and plastic surgery repair notes. In our sample, over 56% of all bites occurred in the head and neck region. Infants were more than 6-times as likely to be bitten in this region compared to any other age group. Pit bull breeds were also more than 2.5 times as likely to bite in multiple anatomic locations.

Sadly, the lone mortality noted in the 1,616 children was a 5-day-old girl bitten on the head by her family's pit bull. The bite created a skull fracture and brain bleed necessitating a neurosurgical emergency to remove the bone and drain the blood. The infant passed away three days later.

Arkansas Experience: Characteristics of Dog Bites in Arkansas. South Med J 2018 Aug; 11(8):494-500.

In a companion study to the Atlanta study, we used a similar methodology examining 740 included patients who presented through the ER in the University of Arkansas for Medical Sciences (UAMS). This study included 574 children who presented to Arkansas Children's Hospital (ACH) and the remainder presented to the adult ER at UAMS. An identical methodology of ER room triage was utilized in this study. The children's data revealed similar findings as 57% of bites occurred in the head and neck region. From a breed identification perspective, breed was reported in 34% of cases. Of those reported cases, 28.1% were identified as 'pit bull' followed next by labradors at 10.7%. Though a small number of children had injuries severe enough to warrant operating room intervention (i.e., n=29), pit bull-injuries were over 3-times as likely to be associated with such an injury. Of the adult patients in which breed was mentioned, pit bulls represented 64.7 % of the sample. Sample size was too small to making meaningful conclusions in the adult population.

Concluding Opinions

Taken together, the obvious limitation in examining our own methodology and data interpretation is identification of breed. However, the preponderance of breeds reported in both studies (in particular, the 46 different breeds in our Atlanta study) leads one to believe that there was not a reporting bias and that the sample of over 500 injured children may very well have had similar characteristics to any other 500 for which breed data could have been recorded.

This, coupled with the overwhelming preponderance of published literature from everywhere in the world - both rural and urban settings alike - citing pit bull injuries causing more morbidity and mortality than other breeds, points to a strong argument for adequate government protection for the public.

While it is true that in isolation it may be difficult to distinguish a pit bull breed, when showed a picture of a chihuahua, a golden-doodle and pit bull breed, I find it difficult to believe that anyone who owns or is frequently around dogs or lives in a place where dogs are commonplace, would not correctly distinguish the obvious differences in such breeds.


As a pediatric plastic surgeon who treats the most severe injuries in children, a dog-owner and a parent myself, the whole of my experience and interpretation of the available literature that a pit bull or pit bull breed having a "bad day" and injuring a person is on average is worse than a chihuahua having a "bad day." Any dog can bite and surely the most common breeds such as labradors (which were included in both our studies, and others) bite commonly. However, one can not ignore the spectrum of injury from a simple nip or scratch to biting an ear or a hand off (which I have personally treated). As for the myriad of breeds available to the potential dog owner, it seems to me the potential risk of owning a pit bull is not worth the benefit - especially when hearing and seeing the severe injuries I have personally treated and the anguish it causes the family members - in many cases causing permanent disfigurement and disability.

Respectfully,

Michael Golinko MD, FAAP, FACS
Chief of Pediatric Plastic Surgery
Director of the Cleft & Craniofacial Program
Director of the Adult and Pediatric Craniofacial Surgery Fellowship
Michael.golinko@vumc.org
718-300-5101

Characteristics of 1616 Consecutive Dog Bite Injuries at a Single Institution

Michael S. Golinko, MD, MA¹, Brian Arslanian, MD²,
and Joseph K. Williams, MD, FAAP^{2,3}

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Abstract

Dog bite injuries remain a common form of pediatric trauma. This single-institution study of 1616 consecutive dog bite injuries over 4 years revealed a much higher prevalence of dog bites as compared with other similar centers. Though inpatient admission was rare (9.8%), 58% of all patients required laceration repair, primarily in the emergency department. Infants were more than 4 times as likely to be bitten by the family dog and more than 6 times as likely to be bitten in the head/neck region. Children ≤ 5 years old were 62% more likely to require repair; and 5.5% of all patients required an operation. Pit bull bites were implicated in half of all surgeries performed and over 2.5 times as likely to bite in multiple anatomic locations as compared to other breeds. The relatively high regional prevalence and younger age of injured patients as compared with other centers is a topic of further study but should draw attention to interventions that can minimize child risk.

Keywords

dog bite injury, pediatric trauma, repair of dog bites

Introduction

Dog bite repairs were among the top 5 reconstructive procedures performed by plastic surgeons, and this number, nearly 27 000 annual repairs, exceeded head/neck and lower-extremity reconstruction.¹ The management of dog bite injuries range from simple washouts and laceration repair to more complex procedures such as craniotomies or replantation. Interestingly, the first partial face transplant was performed on a woman who had been attacked by her Labrador.^{2,3}

From reviewing the statistics in Table 1, it is likely that plastic surgeons interact with only a small fraction of patients who have been injured by a dog and often the most severe. It is emergency department (ED) physicians, pediatricians, primary care providers, and parents, however, who are the vital frontline in education, treatment, and prevention regarding dog bite injuries.

Although precautions can be taken to prevent injury, the trends in the personal and financial cost of dog bite injuries have only increased in recent years. There was an 86% increase in hospitalizations from 1993 to 2008¹⁰ and an 82% increase in fatal dog attacks from the 1980s to 2012.¹¹ Paid homeowners' insurance claims too have increased from \$324 to \$478 million in just 8 years.¹²

This study stemmed from the high prevalence of dog bite injuries treated at our pediatric tertiary hospital,

with an aim to quantify the scope of the problem and identify potential targets of intervention for primary care providers. For surgeons managing extremity and facial trauma, the ultimate goal is to reduce the amount of severe injury encountered by drawing both clinician and lay attention to what may be a preventable threat to children's safety.

Methods

After institutional review board approval, a 4-year retrospective chart review was conducted from ED charts at the Children's Healthcare of Atlanta (CHOA), the only pediatric level I trauma center in the state. Inclusion criteria were the following: patients < 20 years old, male or female, initial triage in the CHOA ED for a dog bite or transfer from another center where primary treatment had not been

¹Arkansas Children's Hospital Division of Plastic Surgery, University of Arkansas for Medical Sciences (UAMS) Little Rock, AR, USA

²Children's Healthcare of Atlanta (CHOA) at Scottish Rite, Atlanta, GA, USA

³Emory University School of Medicine, Atlanta, GA, USA

Corresponding Author:

Michael S. Golinko, Arkansas Children's Hospital Division of Plastic Surgery, 1 Children's Way, Little Rock, AR 72202, USA.
Email: msgolinko@uams.edu

Table 1. Recent Statistics on Dog Bite Injuries.

- 83.3 Million dogs living in more than 50 million households⁴
- 4.5 Million annual dog bites; ~885 000 require medical attention; ~400 000 treated in the ED⁵
- 64.9% Of bites are to the head and neck⁶
- Most prevalent age group: 5-9 years old⁶
- Up to 50% of children may develop posttraumatic stress disorder⁷
- 55.6% Of all mortalities occur in children <10 years old⁸
- 78% Of all deaths from dog attacks between 2005 and 2013 were from pit bulls and Rottweilers⁹

administered, and at least 1 full-thickness wound. Exclusion criteria were as follows: young adults >20 years old, triage visits for suture removal from a dog bite, treatment of a dog bite where initial treatment took place at another center, and bites from animals other than dogs.

Statistical Methods

All data were stored in Microsoft Excel (Microsoft Corporation, Redmond, WA) and aggregate statistics, such as means and SDs, were calculated using Excel. Contingency tables were created for categorical variables (eg, attack by pit bull vs non-pit bull); odds ratios (OR) and CIs were calculated using <http://statpages.org/ctab2x2.html>. Statistical significance ($P < .05$) was reported with a standard 2-tailed P value, using Fisher's exact test. Standard t tests were used in statistical comparison of means and proportions.

Results

Triage Characteristics

A total of 1616 consecutive patients were included. Patients were bitten in 118 unique cities; however, in 320 (19.8%) cases, the city of bite could not be determined. Also, 10 patients (0.6%) were from out of state, and 192 patients (11.8%) were referred from, but not treated at, an outside facility.

As Table 2 summarizes, the majority of patients were young males of school age, and half of all patients were between 5 and 12 years of age. Approximately the same percentage of family dogs and dogs familiar to the child were implicated in injuries. Head and neck injuries (56.5%) were the most prevalent. It was found that 1477 (91.3%) children were bitten in 1 anatomical area, 98 (6.1%) in 2 areas, 31 (1.9%) in 3 areas, and 3 (0.1%) in 4 areas. Canine breed was identified by patient or family report in 31.3% of medical charts.

Of the 46 breeds identified, the 3 most prevalent were 38.5% pit bull (also identified as Staffordshire bull terrier, American Staffordshire terrier, or bull terrier), 13.0% mixed breeds, and 8.1% Labradors. Of the mixed

Table 2. Patient- and Dog-Related Outcome Variables.

Patient Variables	Value (%)
Patients	1616
Percentage male	56.3%
Percentage female	43.7%
Patient age group	6.8 Years (5 days to 20 years)
0-1 Years old	144 (8.9)
1-5 Years old	428 (26.5)
5-12 Years old	808 (50.0)
>12 Years old	236 (14.6)
City of bite identified	1296 (80.2)
Bite injury variables	
Family dog	753 (46.6)
Known to the child (not family)	655 (40.5)
Unknown dog	205 (12.7)
Dog breeds identified	509 (31.3)
Anatomical area	
Head/Neck	1004 (56.5)
Upper extremity	398 (22.4)
Lower extremity	252 (14.2)
Trunk	98 (5.5)
Other	25 (1.4)

breeds ($n = 66$), 11 were pit bull mixes, 12 Labrador mixes, and 4 Labrador/pit bull mixes. Figure 1 illustrates the relative frequency of biting breeds, with font size being a function of relative proportion.

Characteristics of Injury After Triage

Although more than 90% of patients were ultimately discharged, approximately 50% of those still required laceration repair. Approximately 10% of patients required inpatient admission, and 50% of those required an operation; 4.0% ($n = 65$) of patients returned to the ED with a soft-tissue infection (see Figure 2).

Age-Group Analysis

Contingency tables were calculated to compute the OR of the association of a specific age group or groups (risk



Figure 1. Word cloud of the frequency of breeds identified.

factor) with the presence or absence of an injury characteristic—that is, injury in the head/neck area. OR regarding anatomical areas assumes the likelihood of at least 1 bite in each area. Table 3 illustrates these data, with statistically significant results in bold.

Of note, children 5 years old and younger were approximately 62% more likely to require repair in any setting and were between 3 and 6 times as likely to suffer a head and neck injury as compared with other groups. Infants were more than 4 times as likely to be bitten by the family dog and more than 6 times as likely to be bitten in the head/neck region. Lower-extremity injury correlated directly with age. Teenagers were more than twice as likely to sustain extremity injuries and be injured by an unknown dog or a pit bull. Bite injury to the lower extremity was statistically less likely in children younger than 5 years and more likely in children older than 5 years. Dog bites in more than 1 anatomical location was 1.7 times as likely in children 12 years and older as compared with all younger groups. No one age group was any more likely to require operative intervention than another.

Features and Morbidity of Patients With the Most Severe Injuries

In all, 5.5% (89) of patients underwent surgery; of these, 68.5% involved the head/neck region. Of the breeds identified, 50% involved pit bulls. The mean age was 6.3 years old (range = 5 days to 17 years). Table 4 enumerates the primary procedure performed.

With regard to breed, operative intervention was most strongly associated with a pit bull injury: OR = 3.361 (CI = 2.011-5.592); $P < .001$. Pit bull breeds were

also more likely to bite in multiple anatomical locations, OR = 2.660 (CI = 1.598-4.436); $P < .001$. Four returns to the ED from this group were noted, including 2 for an abscess, 1 for exposed hardware, and 1 for wound necrosis. Known operative complications included the following: hand amputation after attempted revascularization, a growing skull fracture, and wound dehiscence with return to the operating room for skin graft placement.

The lone mortality involved a 5 day-old girl attacked on the head by the family's pit bull. The child underwent emergency craniotomy. Her postoperative course was complicated by acute respiratory distress syndrome, neurogenic pulmonary edema, and transfusion-related acute lung injury. Despite maximal ventilator support, she was persistently hypoxic and succumbed on postoperative day 3.

Discussion

Current Literature on Dog Bite Injuries

Dog bite injuries are neither new nor an unstudied phenomenon in children. Table 5 summarizes some of the recent literature emerging from pediatric centers comparable to our own.

On average, the centers cited saw approximately 120 dog bite injuries per year, per institution (range between 17 and 204 per year).¹⁸ Somewhat surprising was that our center averaged more than 400 patients per year. The relatively low population density of Georgia, allowing for larger dogs, and the scarcity of other pediatric trauma centers in the state may account for this high prevalence, but further detailed study is needed to see if dogs are truly biting at a higher rate. There are significant gaps in the literature, as Table 5 illustrates, including detailed data on the biting dog, disposition of the child after ED triage, age in relation to multiple variables, frequency and type of repair, and types of operations performed.

Age and Injury Patterns

The largest ED survey published found that boys 5 to 9 years old²¹ are most susceptible to bite injury. In addition to domestic studies, the world literature is clear: in reports from Canada,²² Spain,²³ Austria,²⁴ South Africa,¹³ Australia,²⁵ Peru,²⁶ India,²⁷ Hong Kong,²⁸ and Bhutan,²⁹ persons younger than 18 years are most at risk for dog bite injury. Our study certainly was consistent with others findings; however, a breakdown into clinically significant age categories provided some new findings.

The age-group analysis in this study indicates that younger children than previously thought are more at risk for injury. Infants (≤ 1 year old), more so than any

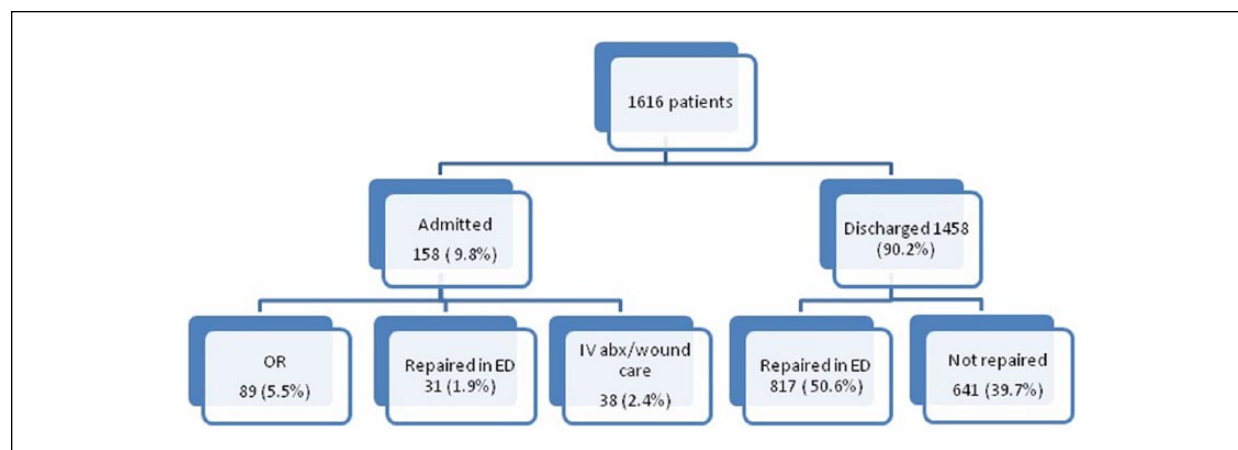


Figure 2. Patient disposition from the ED.

Abbreviations: ED, emergency department; OR, odds ratio IV, intra-venous ABX, antibiotics.

other age group in this study, were most likely to suffer a head/neck injury and be bitten by the family dog or a dog the family knows, and least likely to be bitten by an unknown dog. This was a surprising finding given that most literature points to older children being more susceptible. Moreover, the one mortality in this study of a 5-day old baby girl attacked by her family pit bull should be sobering evidence enough to exercise extreme caution in this age group when in contact with that particular breed. Children younger than 5 years were nearly half as likely to suffer an extremity injury, whereas children older than 12 years were over twice as likely to. These trends may not be merely a matter of total body surface area and height, but also age-specific behavior of children toward dogs—that is, young children kissing or nuzzling the dog and older children playing catch, feeding, washing, or petting.^{30,31} Although the data seem to support a common sense assumption, knowledge of this propensity can guide parents when supervising their young children in the presence of the family pet.

The High-Risk Animal: A Dog You Know

Unfortunately, familiarity may lead to injury. The existing literature reveals that the family dog inflicts injury between 27% and 45% of the time, more so than a neighbors' dog or a stray.^{14,17-19} Some studies we reviewed, however, did not distinguish between a dog known to the family, such as a neighbor's dog, and the family dog. This is a potentially important distinction because we suspect that the more parents (and children) are familiar with a dog, the less vigilant they may be. Our data were consistent with others findings that the family dog was statistically no more likely to be involved in a bite injury than a familiar dog, however: 46.6% and

40.5%, respectively ($P > .05$), and again, infants were most at risk in each of these categories. Whether this finding is indicative of parents' level of supervision around the family dog or whether it is simply because children have more chances to be bitten by the family dog as compared with a dog that is not routinely around, we interpret the data to indicate that parents should demonstrate equal vigilance in all cases. Indeed, in one study of 56 modifiable risk factors, the strongest was "the absence of an able-bodied person to intervene"—present in more than 87% of injuries reviewed.³²

Pit Bull Injuries

Our data confirm what detractors of the breed and child advocates suggest—that, with rare exceptions, children and pit bulls do not mix well. Of the 8 studies listed in Table 5, 6 report pit bulls as the most prevalent breed, and in many cases, they inflicted the most severe injuries.¹⁷ A large study at Children's Hospital of Pennsylvania showed that over a 12-year period, 25% of injuries were caused by a pit bull, and two-thirds of those required an operation.³³ Our data were consistent with others, in that an operative intervention was more than 3 times as likely to be associated with a pit bull injury than with any other breed. Half of the operations performed on children in this study as well as the only mortality resulted from a pit bull injury. Our data revealed that pit bull breeds were more than 2.5 times as likely as other breeds to bite in multiple anatomical locations. Although other breeds may bite with the same or higher frequency, the injury that a pit bull inflicts per bite is often more severe. Consistent with these findings is that of Bini et al,¹⁷ who reported on 228 patients and found that attacks by pit bulls resulted in a higher injury severity score, lower

Table 3. Characteristics by Age Group, as Percentage of the Total in Each Group.^a

Characteristics	Age Group							
	0 to ≤1.0 Year Old (144)		1.0 < Age ≤5.0 Years Old (533)		5.0 < Age ≤ 12.0 Years Old (746)		<12.0 Years Old (193)	
	n (%)	OR (CI), P Value	n (%)	OR (CI), P Value	n (%)	OR (CI), P Value	n (%)	OR (CI), P Value
Head/Neck injury	109 (75.7)	6.197 (4.122-9.350)	389 (73.0)	3.043 (2.429-3.816)	420 (56.3)	0.991 (0.816-1.204)	87 (45.1)	1.194 (0.879-1.622)
Upper extremity	25 (17.4)	0.962 (0.559-1.536)	102 (19.1)	0.784 (0.605-1.017)	201 (26.9)	1.252 (0.992-1.581)	70 (36.3)	2.348 (1.688-3.263)
Lower extremity	9 (6.3)	0.452 (0.212-0.930)	50 (9.4)	0.529 (0.376-0.743)	145 (19.4)	1.635 (1.234-2.166)	48 (24.9)	2.231 (1.535-3.238)
Trunk	8 (5.6)	1.118 (0.489-2.458)	24 (4.5)	0.675 (0.409-1.106)	53 (7.17)	1.389 (0.904-2.134)	13 (6.7)	1.198 (0.624-2.260)
Other	1 (0.7)	0.468 (0.023-3.288)	5 (0.9)	0.510 (0.167-1.448)	14 (1.8)	1.488 (0.632-3.531)	5 (2.6)	5.657 (2.7-11.789)
≥2 Anatomical areas	10 (6.9)	0.846 (0.408-1.703), P = .749	32 (6.0)	0.627 (0.408-0.961)	73 (9.8)	1.310 (0.911-1.883)	24 (12.4)	1.728 (1.052-2.819)
Operative repair	9 (6.3)	1.219 (0.558-2.576)	25 (5.8)	1.364 (0.860-2.160)	48 (5.9)	0.960 (0.611-1.506)	7 (3.0)	0.449 (0.158-1.167)
Family dog	97 (67.4)	4.326 (2.973-6.305)	264 (49.5)	1.644 (1.334-2.025)	306 (41.0)	0.877 (0.721-1.068), P = .188	86 (44.6)	1.611 (1.182-2.195)
Known dog	38 (26.4)	1.617 (1.074-2.427)	206 (26.4)	1.228 (0.992-1.520)	338 (45.3)	1.386 (1.129-1.702)	74 (38.3)	1.441 (1.049-1.979)
Unknown dog	9 (6.3)	0.498 (0.233-1.026)	62 (11.6)	0.940 (0.676-1.306)	101 (13.5)	1.158 (0.855-1.569)	33 (13.5)	1.667 (1.086-2.548)
Pit bull injury	15 (10.4)	0.952 (0.523-1.706)	48 (9.0)	0.706 (0.493-1.009)	99 (13.2)	1.255 (0.919-1.715)	31 (16.1)	1.644 (1.059-2.541)

^aOdds ratios (ORs) are reported, calculated with age as the independent variable. Confidence intervals are reported; those that are statistically significant, with P < .05, are in bold.

Table 4. Frequency of Operative Procedures in 89 Patients Suffering Dog Bite Injuries.

Operating Room Procedure	n (%)
Irrigation and closure	60 (65.9)
Canalicular repair	11 (12.1)
Wound irrigation and debridement	4 (4.4)
Craniotomy	3 (3.3)
Dural repair	2 (2.2)
Facial nerve repair	1 (1.1)
Local facial flap	1 (1.1)
ORIF humerus	1 (1.1)
ORIF mandible	1 (1.1)
ORIF radius	1 (1.1)
ORIF phalanx	1 (1.1)
Replant lip	1 (1.1)
Revascularization of hands	1 (1.1)
Tooth extraction	1 (1.1)

Abbreviation: ORIF, open reduction, internal fixation.

Glasgow coma score, higher risk of death, and higher hospital charges than attacks by any other breed.¹⁷

Morbidity of Dog Bite Injuries

Whereas existing studies focus on only bites repaired in the ED or only the most severe requiring the OR, this study sought to follow patients longitudinally throughout their course from triage to treatment and disposition. Summarizing from Table 5, national admission rates range between 6.4%¹⁵ and 22.5%,¹⁶ and operative rates range between 3.1%¹⁵ and 25.2%.²⁰ This study revealed that 57.9% of patients required some form of repair following a dog bite, 9.8% of patients required inpatient admission, and more than 50% of admissions were associated with an operation. Younger children (mean age = 6.3 years) tended to require an operation. Although the majority of injuries required only washout and closure, revascularization of the hands, ORIF of long bones, and craniotomies were among the singular reminders of the severity of trauma a dog can inflict on a child; also, whereas the common laceration may not be preventable in many cases, these severe injuries often need not occur. Regardless of treatment setting, copious irrigation with betadine and saline, sharp debridement of any macerated or damaged tissues, deep closure with monocryl as needed, and loose skin approximation with permanent sutures, along with a 10-day course of amoxicillin/clavulanate potassium or clindamycin is advised. Families should be counseled that avoidance of secondary infection is more important in the short term than cosmesis because an unsightly scar can always be revised.

Limitations and Bias

Because this was a retrospective review of triage and medical record data, certain variables such as breed of dog could not be independently verified. There may be a reporting bias for typically “biting” breeds, such as pit bulls. Although 1616 consecutive children were included, 1608 of these were unique because 8 children were bitten at 2 separate time points and returned to the ED for treatment. Analysis of the same or different dog responsible for each bite was beyond the scope of this study but would be important to investigate. Another source of error is in the city of bite because data recorded where the bite took place may not necessarily be where the animal normally resides. Often, bites occurred at home, for which data would be accurate. Comparison of admission, ED, and surgical repair rates are biased by institutional resources and local physician practice patterns. The authors acknowledge that etiology of a dog bite is complex and multifactorial, depending not only on the canine’s characteristics, but also on owner training, child behavior, and the specific conditions when the bite occurred. Operative complications and returns to the ED following a repair for a soft-tissue infection are likely underestimated as well because many patients may have sought care at their local physician’s office and not returned to the original point-of-service.

Potential Public Health Interventions

The health care providers who see the accidental and often deleterious effects of dog bite injury are vastly outnumbered by the heads of the approximately 56.7 million households³⁴ who own dogs under the likely assumption that the dog will not harm them or their child. Several studies reflect this hypothesis^{35,36} and revealed that the majority of parents assumed that their infants were not at risk for an attack. As a Cochrane database review suggests, it is often better to educate the parents and pediatricians rather than children directly.³⁷ Alarming, one survey of 254 parents revealed that only two-thirds believed that a dog could be the cause of a fatal infant injury.³⁶

At least in the United States, “man’s best friend” is part of the national psyche and is reinforced for children in the form of stuffed animals, cartoon characters, and animated movies. In this milieu, it is all the more important for any clinician, using data from this study and others, to caution parents appropriately about the potential hazards that specific canine situations may pose to their child. Inquiring and counseling about dogs at home and in the neighborhood should be as important and integral a part of any pediatric encounter, as would be cautioning

Table 5. Selected Studies of Dog Bite Injuries With Select Variables That Could Be Targets of Public Health Intervention.

Authors (Year Published)	Study Length(years)	Patients (n)	City (Type of Site)	Two Most Prevalent Breeds Documented (%)	Percentage Family Dog	Percentage Familiar (But Not Family)	Percentage Unknown	Percentage Admitted/ Operating Room	Mean or Most Prevalent Age Range (years)
Dwyer et al, ¹³ 2007	13	1871	Cape, Town South Africa (1 Children's Hospital)	<ul style="list-style-type: none"> • PB 28% • GS 21% • 1% 					6.8 years old
Daniels et al, ¹⁴ 2009	7	1347	Indianapolis, IN (2 children's hospitals)	<ul style="list-style-type: none"> • PB 12% • GS 2.4% • 28% (inpatient only) 	37%	33%	7%	8.1%/4.5%	7.8 Years old
Kaye et al, ¹⁵ 2009	5	551	Philadelphia, PA (children's hospital)	<ul style="list-style-type: none"> • PB 50.9% • R 8.9% • 48.8% 	68.8% (Family + dog friend)			6.4%/3.1%	6-12 Years old (51%)
Chen et al, ¹⁶ 2013	5	537	Aurora, CO (children's hospital)	<ul style="list-style-type: none"> • M 23% • L 13.7% 	89.8% (Family + dog friend)		11.2%	22.5% Admit	68% ≤ 5 Years old
Bini et al, ¹⁷ 2011	15.5	228 (Admitted only)	San Antonio, TX (trauma hospital)	PB 35%	44.8%	43.1%	12.1%		21 Years old
Bernardo et al, ¹⁸ 2000	1	204	Pittsburgh, PA (children's hospital)	<ul style="list-style-type: none"> • PB 19% • GS 12% • 47% 	27%	28%			6.8 Years old; <5 Years: 49%
Reisner et al, ¹⁹ 2011	3.5	203	Philadelphia, PA (children's hospital)	<ul style="list-style-type: none"> • M 28% • PB 22% 	72% (Family + dog friend)		9%		7.2 Years old
Wu et al, ²⁰ 2011	5	87	Springfield, MA (tertiary hospital)					25.2% OR	6.8 Years old

Abbreviations: PB, pit bull; GS, German Shepherd; R, Rottweiler Pincher/Rottweiler; M, mixed; L, Labrador.

For Parents:

- Determine what dogs live in the neighborhood and take appropriate precautions
- Refrain from leaving children under 5-years-old unsupervised with a dog of *any* breed, family or otherwise
- Never leave a child under 1 year-old alone with **any** dog
- Exercise identical precautions when children are interacting with the family or a familiar dog
- Dissuade or prevent children from behavior that brings their face in close proximity to the dogs
- Avoid interacting with the dog when its' eating, sleeping or nursing- and allow their children to learn this habit
- Strong consideration to avoidance of any interaction between pit bull breeds and young children, particularly infants

For Primary Care Providers

- Counsel parents as above, and that the #1 way to avoid accidental injury is supervision

Emphasize avoidance of secondary infection as opposed to cosmesis on in the initial repair

- Have a low-threshold for surgical consult to ensure adequate irrigation and debridement under anesthesia
- Routine patient encounters are an opportunity to inquire about *any* dog that children could routinely come in contact with, not just the family dog.

Figure 3. Select recommendations for primary care practitioners and parents based on study findings.

parents about the hazards of handguns, trampolines, or monkey bars.

Though a full discussion of the range of public health interventions is beyond the scope of this report, several comments can be made. There is no shortage of passion or emotion when it comes to the question of banning certain breeds as many owners of the accused dogs staunchly defend their “members of the family.” The debate is an active one because, recently, the parents of children attacked by pit bulls petitioned state lawmakers in Georgia for a ban on the breed.³⁸ In certain locations, as in Canada, breed specific legislation has been shown to decrease the incidence of bites.³⁹ Consider even that in Aurora, Colorado, where pit bulls have been banned since 2006, a recent study of 537 children found that Labradors were the second most-prevalent biting breed (13.7%), second only to mixed breeds. In other words, a ban of any particular dog alone will not necessarily prevent the severe injuries and mortality, but rather a change in interaction and supervision of children with dogs of any breed. Figure 3 offers some recommendations and is adapted from Reisner et al¹⁹ and American Veterinary Medical Association Task Force on Canine Aggression and Human-Canine Interactions.⁴⁰

Conclusions

This is the first detailed study of dog bite injuries in Georgia and one of the largest studies conducted at a

pediatric trauma center. Our study revealed that whereas more than half of all injuries necessitate repair, only approximately 5% require operative intervention. The data also suggest that younger children (<5 years old) than previously reported, and particularly infants, are at high risk for the most severe injuries. The study corroborates the largely negative interactions between pit bulls and children of any age. Parental education and supervision may be the most important measure to prevent severe dog bite injuries.

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Author Contributions

MSG conceived the study idea and developed the research design with JKW. MSG wrote the initial drafts of the manuscript. MSG and BA spear-headed data collection, analysis and along with JKW wrote and edited all portions of the manuscript. JKW provided key insights and changes in discussion and data presentation.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Characteristics of Dog Bites in Arkansas

Aaron M. Smith, MD, Jacob Carlson, MD, Ashley B. Bartels, MD, Cody B. McLeod, MD, and Michael S. Golinko, MD

Objective: Dog bite injuries are encountered frequently in emergency departments and can cause significant morbidity. The objective of this study was to explore the associations between the multiple variables at play during these occurrences (eg, the patient's age, the bite location, the bite severity, the dog's relationship with the patient, the breed of dog).

Methods: This two-institution study collected and analyzed dog bite data from Arkansas' only Level I trauma centers. The charts of 740 patients were included in our retrospective chart review. The chart review extracted data, including each individual patient's age, sex, dog bite location, and dog bite severity, as well as the patient's relationship to the dog and the dog's breed. To determine the relation between and among variables, contingency tables were created and analyzed to determine odds ratios (ORs) and confidence intervals (CIs). In addition, standard *t* tests were used in statistical comparisons of means and proportions.

Results: Of the 740 patient charts reviewed, 574 were for patients who presented to Arkansas Children's Hospital and 166 were for patients who presented to the University of Arkansas for Medical Sciences. Of the patients across both institutions, 267 (37.1%) required some form of repair, with 225 (30.4%) receiving closure within the emergency department and 42 (6.7%) requiring an operative intervention. Among children, those younger than age 5 years were >8 times as likely to require an operative repair (OR 8.1, 95% CI 2.77–23.58, $P < 0.0001$), >4 times as likely to be bitten on the head and neck (OR 4.30, 95% CI 3.00–6.16, $P < 0.0001$), and ≤3 times as likely to be bitten by a family dog (OR 2.97, 95% CI 2.10–4.20, $P < 0.0001$). Conversely, children older than age 12 years were >3 times as likely to be bitten on an extremity (OR 3.43, 95% CI 2.08–5.65, $P < 0.0001$).

Conclusions: The results of this retrospective review are aligned mostly with the general trends found in previous national and global studies, supporting the notion that family dogs represent a more significant threat than often is realized and that, among the breeds identified, pit bulls are proportionally linked with more severe bite injuries. Our data further validate previous studies that note an increased risk of bites and bite severity in children younger than 5 years. In addition, our data

show that bites to the head and neck occurred more frequently among children younger than 5 years than among older children, and that boys younger than 5 years were bitten more frequently than girls.

Key Words: dog bites, pediatric emergency, pit bull, trauma

Dog bites are encountered frequently in medicine and can lead to significant morbidity in both children and adults. According to the Centers for Disease Control and Prevention, there are approximately 4.5 million dog bites per year in the United States.¹ Furthermore, in 2013 the American Society of Plastic Surgeons (ASPS) ranked dog bite repairs among the top five reconstructive procedures performed by plastic surgeons and, although ASPS statistics show a decrease in such reconstructive procedures, the staggering numbers of dog bites requiring reconstruction remain, with a reported 28,991 performed by plastic surgeons in 2016.² In addition, dog bite injuries in the United States have been reported to account for 0.3% to 1.1% of all emergency department (ED) visits, with a disproportionately high number of these bites occurring in children.³ Although other institutions have previously collected data regarding dog bite-related ED visits, no detailed study has been conducted concerning pediatric and adult patients within our region.

The objective of this study was to collect and analyze dog bite data within the state of Arkansas, in the hope that those findings may be applicable broadly, providing clinicians everywhere greater insight into what often is a preventable cause of childhood morbidity. Arkansas Children's Hospital (ACH) and University of Arkansas for Medical Sciences (UAMS) are the only Level I trauma centers in Arkansas; thus, they uniquely encompass all Level I trauma cases that presented during approximately a 5-year period. Evaluation of their collected data provides an accurate understanding of the variety of dog bite injuries occurring within the state, as well as insight into the broader nature of dog bites occurring universally. To effectively present the data and better grasp their implications, the individual data for ACH and UAMS are presented, followed by a brief overview of the

From the Arkansas Children's Hospital and the University of Arkansas for Medical Sciences, Division of Plastic Surgery, Little Rock.

Correspondence to Dr Michael S. Golinko, University of Arkansas for Medical Sciences, Department of Surgery, Division of Plastic Surgery, Arkansas Children's Hospital, 1 Children's Way, Little Rock AR 72202. E-mail: msgolinko@uams.edu. To purchase a single copy of this article, visit sma.org/smj-home. To purchase larger reprint quantities, please contact Reprintsolutions@wolterskluwer.com.

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Key Points

- Dog bite injuries often are encountered in emergency departments and are a cause of significant morbidity.
- Children younger than age 5 years are at significantly greater risk for more severe injuries and for being more frequently bitten on the head and neck.

combined data. The data and the factors associated with bite severity and occurrence are analyzed in the Discussion.

Methods

With the aim of better understanding the scope of the dog bite problem within Arkansas and, by extension, rural states in general, a retrospective chart review was conducted with records from ACH and UAMS. After institutional review board approval at both institutions, 740 total records were collected for analysis (Fig. 1).

At ACH a 5-year retrospective chart review of 574 children who presented to the ED was conducted. Inclusion criteria for the ACH study were all male and female patients younger than 18 years who presented with a dog bite between October 1, 2011 and October 1, 2016. Patients at ACH who were older than 18 years seen merely for suture removal or seen for bites from animals other than dogs were excluded from the study.

At UAMS, 166 total records were collected from a 6-year period (January 1, 2010–January 1, 2016). Of these, 31 patients' records were obtained from UAMS's trauma registry, whereas the other 135 records were collected of individuals with nontrauma bites presenting to the UAMS ED. The UAMS study included both male and female patients older than 18 years who presented with dog bite injuries. Patients at UAMS being seen for suture removal or for bites from animals other than dogs were excluded from the study.

Electronic medical records were accessed using Epic (Verona, WI) and MEDITECH (Westwood, MA) software. The patient data were extracted and incorporated into REDCap's project management system. Information obtained from each patient's chart included age, sex, date of incident, dates of service, type of intervention, location of incident, physical location of injury, breed of dog, and relation of the dog to the patient. After entering all of the data into a REDCap

collection instrument, the completed datasets were exported into Microsoft Excel (Microsoft, Redmond, WA). Tables were created and analyzed to determine odds ratios (ORs) and confidence intervals (CIs). The OR, its standard error, and the 95% CI were calculated using MedCalc version 17.7.2 (MedCalc Software, Ostend, Belgium). Standard *t* tests were used in statistical comparison of means and proportions.

Results

ACH

The dataset that was collected from ACH was more complete than that which could be collected from UAMS, offering a more comprehensive and reliable depiction of the nature of dog bites within the state. At ACH specifically, 574 patients with an average age of 7.36 years were bitten across 42 identified counties within the state of Arkansas. These 574 patients broadly represent Arkansas children (ie, those younger than 18 years). Table 1 shows patient- and dog-related outcome variables for all patients seen at ACH and variables specific to those patients at ACH who required operative intervention. Family dogs, bites to the head and neck, and pit bull-associated injuries positively correlated with the need for operative intervention.

Table 2 depicts the four different age groups of children treated for dog bites at ACH (as well as a column for patients at UAMS). ACH data suggested that younger children were susceptible to the most severe injury, with 3.92 years being the average age of a child requiring an operative intervention, compared with all studied patients at ACH, who had an average age of 7.36 years. Furthermore, patients younger than age 5 years were 8 times as likely to require an operative repair (OR 8.1, 95% CI 2.77–23.58, $P < 0.0001$).

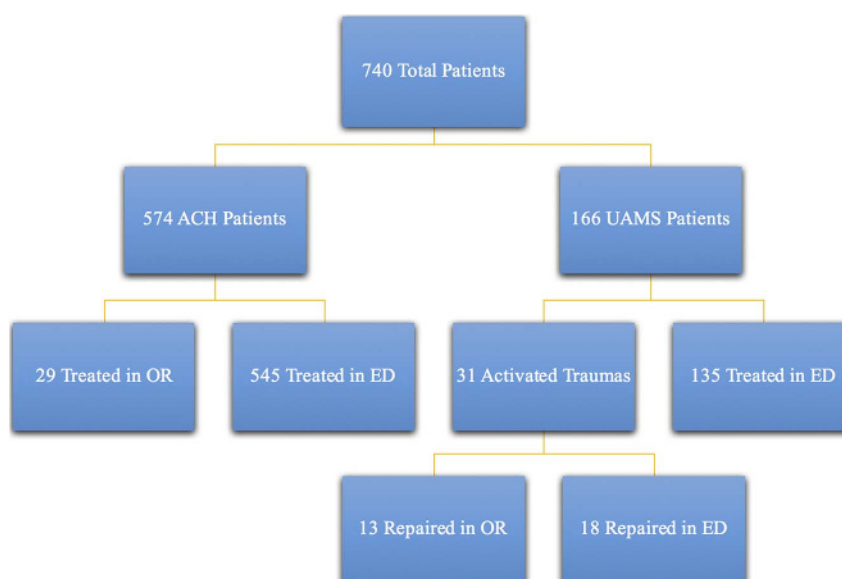


Fig. 1. Breakdown chart of treatment route for patients presenting to either ACH or UAMS emergency department with dog bite injuries. ACH, Arkansas Children's Hospital; ED, emergency department; OR, operating room; UAMS, University of Arkansas for Medical Sciences.

Table 1. Patient- and dog-related outcome variables for ACH

All ACH patients (n = 574)		Subset of ACH patients requiring operating room reconstruction (n = 29)			
	Value (%)		Value (%)	OR (95% CI)	P
Patient variables		Patient variables			
Male	310 (54.0)	Male	17 (58.6)	1.20 (0.56–2.57)	0.63
Female	264 (45.0)	Female	212 (41.4)	0.83 (0.38–1.76)	0.63
Relationship variables (n = 515) ^a		Relationship variables (n = 27) ^b			
Family dog	232 (45.0)	Family dog	20 (71.4)	3.48 (1.45–8.39)	< 0.05
Dog known to child	196 (38.1)	Dog known to child	6 (22.0)	0.46 (0.18–1.17)	0.10
Unknown dog	87 (16.9)	Unknown dog	1 (3.7)	0.19 (0.02–1.41)	0.10
Anatomical area (n = 616) ^c		Anatomical area (n = 32) ^d			
Head/neck	327 (57.0)	Head/neck	27 (93.1)	4.77 (1.81–12.55)	< 0.05
Upper extremity	157 (27.4)	Upper extremity	2 (6.9)	0.19 (0.05–0.82)	< 0.05
Lower extremity	99 (17.2)	Lower extremity	2 (6.9)	0.35 (0.08–1.48)	0.15
Trunk	26 (4.5)	Trunk	1 (3.5)	0.73 (0.10–5.67)	0.76
Perineum/genitals	7 (1.2)	Perineum/genitals	0	1.25 (0.07–22.37)	0.88
Pit bull associated (n = 196) ^e	55 (28.1)	Pit bull associated (n = 17) ^f	10 (58.8)	3.66 (1.33–10.10)^g	< 0.05
Requiring no repair	333 (58.0)				
Requiring closure in ED	212 (36.9)				
Requiring operative repair	29 (5.0)				

Boldface type indicates statistical significance. ACH, Arkansas Children's Hospital; CI, confidence interval; ED, emergency department; OR, odds ratio.

^aRelationship variable not reported in 59 cases.

^bRelationship variable not recorded in 2 charts.

^c574 patients represented; n = 616 because several patients were bitten in multiple anatomical locations.

^d29 patients represented; n = 32 because 1 patient bitten in 4 anatomical locations.

^eLabradors were reported second most frequently biting, with 21 (10.7%). In addition, it should be noted that only 34% of charts identified a dog breed.

^fAmong the other breeds reported, 2 (11.8%) were identified as "mixed breed." Several other breeds (border collie, doberman pinscher, mastiff, labrador, and golden retriever) were identified in a single attack each, accounting for 5 (29.4%) bites repaired in operating room.

^gSignificance questionable, with lack of reporting and likely reporting bias.

It is not surprising that the majority of patients come from Pulaski County, in which ACH is located, and its neighboring counties (Fig. 2). Because ACH is the only Level I trauma center in Arkansas, however, patients from distant counties and from outside the state are still represented, and, unfortunately, often are characterized by relatively severe injuries. This increased morbidity can be illustrated when comparing patients from Pulaski County with patients from outside counties, where they were nearly 6 times as likely to require an operative intervention (OR 5.72, 95% CI 2.38–13.68, $P = 0.00001$).

UAMS

The 166 patients who received treatment at UAMS during a 6-year period are depicted in Table 2. For many of these, factors such as the dog's breed, the relationship of the dog to the patient, and specifics of nonoperative treatments (eg, procedure notes) were unavailable; however, more complete records were available on 31 of the patients who were activated as trauma cases (Table 3). Of the 13 trauma cases in which a breed was recorded, pit bulls were represented in 69% of cases (OR 5.09, 95% CI 0.96–26.78, $P = 0.056$) and no other breed accounted for more than a single attack (7.7%). Incomplete reporting (approximately

one-third of trauma records did not identify a breed) and the likely reporting bias toward pit bulls should be considered in interpreting these data, however.

Collective Data

The average age across both institutions was 15.1 years, with 37.1% of all patients younger than 5 years. The youngest patient in our total dataset was 3 months old and the oldest was 89 years old. Overall, male patients were bitten slightly more frequently (51.6% of cases). In addition, male children were approximately 50% more likely to be bitten (patients at ACH) when compared with adults (patients at UAMS; OR 1.53, 95% CI 1.08–2.17, $P = 0.0161$). Conversely, adult female patients were approximately 50% more likely to be bitten compared with children (OR 1.53, 95% CI 1.08–2.17, $P = 0.0161$).

Discussion

Age and Severity

Arkansas' dog bite data seem mostly consistent with what has been reported at other institutions. Although there is a worldwide consensus in the literature that individuals younger than 18 years

Table 2. Characteristics by age group

	ACH				UAMS ^a
	<1 y (N = 16)	1–5 y (N = 247)	6–12 y (N = 236)	>12 y (N = 75)	>18 y (N = 166)
	n (%)	n (%)	n (%)	n (%)	n (%)
Head/neck	13 (81.0)	185 (74.9)	108 (45.8)	21 (28.0)	19 (31.7)
Upper extremity	3 (18.8)	49 (19.8)	75 (31.8)	30 (40.0)	31 (51.7)
Lower extremity	1 (6.3)	18 (7.3)	56 (23.7)	24 (32.0)	31 (51.7)
Trunk	0	3 (1.2)	19 (8.1)	4 (5.3)	3 (5.0)
Perineum/genitals	0	1 (0.4)	5 (2.1)	1 (1.3)	0
Operative repair	2 (12.5)	23 (9.3)	4 (1.7)	0	13 (7.8)
Family dog	12 (75.0)	132 (58.9)	73 (35.4)	15 (21.7)	22 (51.2)
Known dog	2 (12.5)	68 (30.4)	95 (46.1)	31 (44.9)	12 (27.9)
Unknown dog	2 (12.5)	24 (10.7)	38 (18.4)	23 (33.3)	9 (20.9)
Pit bull injury	1 (20)	23 (26.7)	23 (28.8)	8 (32.0)	11 (64.7)
Most commonly represented breeds	Dachshund 2 (40.0), pit bull 1 (20.0), chihuahua 1 (20.0), terrier 1 (20.0)	Pit bull 23 (26.7), Labrador retriever 12 (12.8)	Pit bull 23 (28.8), Labrador retriever 8 (10.0)	Pit bull 8 (32.0), German shepherd 6 (24.0) ^b	Pit bull 11 (64.7), mix 2 (11.8)

ACH, Arkansas Children's Hospital; UAMS, University of Arkansas for Medical Sciences.

^aRelationship could be identified in only 43 patients (25.9%).

^bTwo of the German shepherd bites in this category represent police dog bites; however, German shepherds remain the second most common breed in the >12 y category even when corrected for this fact.

are the most susceptible to bite injury, one of the largest studies to date, which was based upon national ED statistics, found that boys from 5 to 9 years old were the most susceptible to bite injuries.³ Recognizing that the severity of injuries varies disproportionately among age groups and that the Level I trauma institutions involved in our study tend to receive our state's most severe injuries, our study is more limited in its

ability to draw conclusions about the total incidence of dog bites among any specific age group; any age group sustaining less severe injuries would be seen more often at regional hospitals and thus be underrepresented in our data. Our data, however, provide evidence that children and infants younger than 5 years are susceptible to the most severe trauma, a notion that is further supported by data collected from the Children's Hospital of Atlanta.⁴

The frequency with which younger children were bitten on the head or neck may be one factor explaining the increased severity among younger children (Fig. 3); indeed, in our study, children younger than 5 years were >4 times as likely to be bitten on the head and neck (OR 4.30, 95% CI 3.00–6.16, $P < 0.0001$), whereas children older than 12 were >3 times as likely to be bitten on an extremity (OR 3.43, 95% CI 2.08–5.65, $P < 0.0001$). Furthermore, when comparing both institutions, patients at ACH were bitten on the head and neck significantly more often than were patients at UAMS (OR 2.86, 95% CI 1.62–5.04, $P = 0.0003$). Upper extremity wounds were more than twice as common in the patients at UAMS, however (OR 2.17, 95% CI 1.30–3.60, $P = 0.0029$). Moreover, when considering all of the patients, the difference between the mean ages of patients bitten on the head and neck and patients bitten on the extremities was 7.47 years, with a 95% CI of 5.26 to 9.67; $P < 0.0001$. It is reasonable to assume that this propensity for bites to the head and neck among young children is largely the result of their disproportionately large head size and their age-specific behaviors (ie, young children kiss and nuzzle, whereas older children feed, wash, pet, or play catch with dogs).^{5,6}

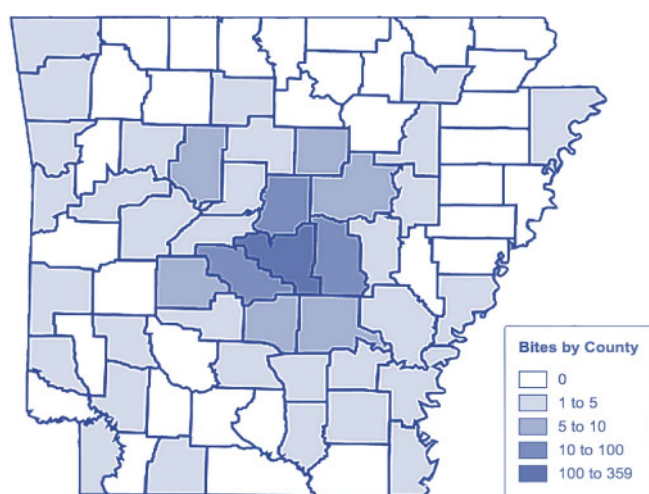


Fig. 2. County map of Arkansas depicting comparative number of patients transported to ACH from 42 distinct counties, with shades of blue being a function of relative proportion. The county in which the bite occurred could not be determined for 39 (5.3%) of patients at ACH. ACH, Arkansas Children's Hospital.

Table 3. Patient- and dog-related outcome variables for 31 UAMS trauma patients, January 1, 2010–October 31, 2016

Patient variables	Value (%)
Sex	
Male	12 (38.7)
Female	19 (61.3)
Required operating room repair	13 (41.9%)
Relationship variables (n = 21) ^a	
Family dog	11 (52.4)
Known dog	7 (33.3)
Unknown dog	3 (14.3)
Anatomical area (n = 35) ^b	
Head and neck	16 (57.1)
Upper extremity	14 (50.0)
Lower extremity	3 (10.7)
Trunk	2 (7.1)
Perineum/genitals	0
Pit bull associated (n = 13) ^c	9 (69.2)

UAMS, University of Arkansas for Medical Sciences.

^aRelationship variable not recorded in 10 cases.

^b31 patients represented; n = 34 because 1 patient bitten in 3 anatomical locations and 2 patients were bitten in 2 anatomical locations.

^cNo other breed recorded (akita, black mouth cur, German shepherd, and terrier) accounted for more than a single attack. It should be noted that roughly one-third did not report the breed of dog involved.

Family Dogs

Consistent with previous findings, Arkansas data further suggest that younger children and infants are more frequently bitten by family dogs; those younger than 5 years were 3 times as likely to be bitten by a family dog (OR 2.97, 95% CI 2.10–4.20, $P < 0.0001$). This increased proportion of children and infants being bitten by family pets is a well-identified phenomenon recorded in multiple previous dog bite studies,^{7–9} and, regrettably, appears to be partially the result of a highly modifiable factor: parental attentiveness. Moreover, one study revealed that in 87% of severe dog bites, an able-bodied

person was absent from the scene and unable to intervene during the attack.¹⁰

Pit Bulls

Pit bulls previously have been highlighted in data collected from children's hospitals in Atlanta, Indianapolis, Philadelphia, Pittsburgh, and Cape Town, South Africa^{7,9,11–13} and in data collected from adult populations with biting more frequently and more destructively.^{4,8} Because <30% of cases reported a breed when looking across both institutions in our study, any conclusions linking dog breed with bite incidence, severity, or both must be drawn cautiously. When looking at individual institutions such as ACH or UAMS, the accurate measurement of incidence specifically proves problematic: If pit bulls are capable of inflicting more severe injuries, then they will be excessively represented at centers offering definitive care for more severe injuries. With regard to severity, however, it is reasonable to assume that any large breed with powerful jaws would be capable of inflicting severe injuries. Indeed, when looking at cases that required operative interventions, pit bulls were disproportionately represented in 62.5% of cases (OR 3.71, 95% CI 1.54–8.91, $P = 0.0033$).

Treatment

Patients taken into the operating room primarily underwent simple irrigation and closure, most commonly for head and neck lacerations. Of specific reconstructions, canalicular repairs were most frequent, representing a total of seven instances. Wounds involving the vermilion border also were commonly closed in the operating room or under conscious sedation, because irregularities in this area are highly conspicuous.

Receiving the most notable injuries in the adult population was a 75-year-old man whose significant extremity trauma inflicted during a pit bull attack resulted in 29 days in the hospital, a finger amputation, and an eventual above-the-knee amputation. Exclusive to the adult population were five instances of incision and drainage that took place in the operating room and were required for infection that developed after a forbearance of

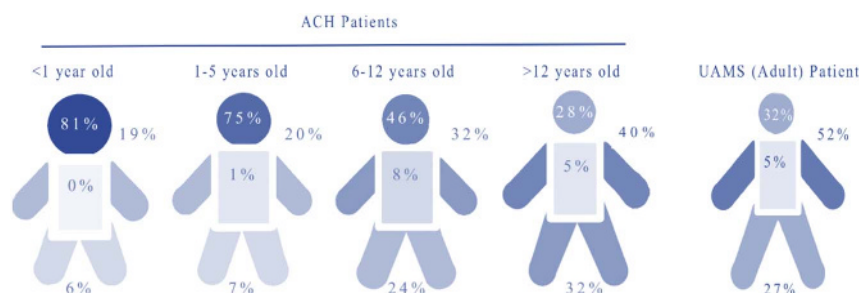


Fig. 3. Humanoid symbols comparing the dog bite frequency of four anatomical areas with patient age. Frequency of recorded bites to body area are depicted in text; shades of blue indicate function of relative proportion of bites to an area. The chart offers an intuitive way of viewing variations in injury patterns between age groups. It is noteworthy, however, that although complete records existed for all patients at ACH, anatomical location was identified only in 56.6% of patients at UAMS. ACH, Arkansas Children's Hospital; UAMS, University of Arkansas for Medical Sciences.

treatment. Other severe injuries included two open-globe repairs and an avulsed lateral rectus, as well as an open reduction internal fixation for a comminuted metacarpal fracture.

A 3-year-old girl experienced the most notable pediatric incident. Attacked by her family's pit bull, she required a stay of 22 days in the hospital for severe facial injuries. With severe trauma to her nasal cavity and scalp, as well as total loss of an oral commissure and canalicular damage, she received multiple reconstructive surgeries, including an anterior lateral thigh free-tissue transfer. Our only child younger than 1 year to receive operative intervention required repairs for a skull fracture and scalp lacerations after her family's pit bull attacked her. Skull or facial fractures were noted in three children, one of whom had a severe descalping injury resulting from an attack by multiple pit bulls, which required Integra matrix wound dressing (Integra, Plainsboro, NJ) placement and reconstruction involving tissue expansion.

Basics of Treatment

The basics of treatment initially should focus on Advanced Trauma Life Support (ATLS) principles. Assuming that the patient does not have airway or breathing concerns requiring immediate action, direct pressure may be used to stop the bleeding in most cases, whereas severe cases may require a tourniquet proximal to extensive extremity trauma. After initial stabilization and thorough assessment to exclude multisystem trauma requiring emergent action, a thorough irrigation and debridement often is justified. To facilitate this, local anesthetic may be injected before beginning treatment. Irrigation may include 1% povidone-iodine or 1% benzalkonium chloride and/or pressure irrigation with normal saline.¹⁴ Proper debridement should remove all of the devitalized tissue. Although closure often is discouraged after dog bites because of infection risks, especially as seen within the primary care literature,¹⁵ there are many factors (eg, coexisting medical conditions; characteristics of the injury, including its location, blood supply, age, and depth) that should be considered before deciding to leave a wound open. In this regard, primary closure is in general recommended in areas of cosmetic importance with the option to place a small drain or penrose drain.

In addition, the importance of medical treatment cannot be overstated. One study revealed that one-third of patients presenting to the ED with an infected dog bite would require admission.¹⁶ Dog bites often are polymicrobial, aerobic and anaerobic, and commonly associated with *Pasteurella multocida* (~50%).¹⁷

As far as medical treatments are concerned, rabies and tetanus vaccinations should be considered, and antibiotic prophylaxis is almost always recommended. In adults, first-line treatment includes amoxicillin/clavulanate, 875/125 mg every 12 hours; alternatives include clindamycin, 300 mg 3 times per day, plus ciprofloxacin, 500 mg 2 times per day, or doxycycline, 100 mg 2 times per day. In pregnant women allergic to penicillin, azithromycin, 250 to 500 mg/day, should be considered. In children, first-line treatment includes amoxicillin/clavulanate, 25 to 45 mg/kg every 12 hours; alternatives include clindamycin,

10 to 25 mg/kg every 6 to 8 hours plus trimethoprim-sulfamethoxazole, 8 to 10 mg/kg every 12 hours.¹⁴ In the case of an older wound that appears infected, it is advisable to obtain a Gram stain as well as aerobic and anaerobic cultures from the depth of an infected puncture/laceration to better target antibiotic therapy. Aerobic and anaerobic blood cultures certainly should be collected if a patient has signs of or is at risk for systemic infection, and if sepsis criteria are met, protocol (eg, administering broad-spectrum antibiotics, accessing lactate level) should be initiated immediately.

In our retrospective review, there was a possibility for reporting bias, and as previously mentioned, one could reasonably assume that the alleged ferociousness of pit bulls may have increased the frequency in both reporting and recording via the electronic medical record. It also should be noted that breed was identified and recorded in the electronic medical record in only 58.6% of ACH operating room cases, 41.9% of UAMS trauma cases, and 28.7% of cases overall, a limitation to our study. Furthermore, although some data are available regarding the proportions of various breeds throughout the United States, the breed census as they exist within Arkansas and Pulaski County are not known. Also, the relative frequency of pit bull bites recorded at ACH is likely elevated by the increased severity of such bites, considering that severe bites are more likely to be perceived as warranting an ED visit by dog owners and by the fact that Arkansas' most severe dog bites funnel into ACH and UAMS (our state's only Level I trauma centers).

In addition, although it would have been ideal to have collected the exact same years of data at both institutions, 6 years of data were collected at UAMS, whereas only 5 years of data were collected at ACH. It should be noted this difference had some effect on the recorded incidence and could have skewed the data.

Conclusions

Our study represents the first detailed study of dog bites conducted within Arkansas. Approximately 5 years of data were collected from our state's only Level I trauma centers: ACH and UAMS. Across both institutions, our study revealed that 36% of cases needed repair, yet only 6.7% required operative intervention. Lacking some concordance with much of the previous literature, our study supports the notion that younger children (younger than 5 years) are at greater risk for more severe injuries. Moreover, those younger than 5 years were >8 times as likely to require operative repair, >4 times as likely to be bitten on the head and neck, and >3 times as likely to be bitten by a family dog. In addition, our study revealed that male children are more likely to be bitten, which is consistent with the literature. Uniquely, however, our data suggested that adult females were more often seen for dog bites. Our study corroborates much of the previous literature, supporting the notion that pit bull bites are severe enough to require operative intervention more frequently than the bites of other dog breeds.

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